POWER SUPPLY CONTROL METHOD AND DEVICE

IN PORTABLE COMMUNICATION DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a portable communication device such as a mobile telephone terminal or a portable

5   information processing terminal and in particular to techniques of controlling the power supply of a portable communication device equipped with a plurality of controllers.

2. Description of the Related Art

In a mobile communications system as shown in Fig. 1,

10   a plurality of base stations 10 each labeled with "BS" are distributed over service areas SA, SB. The respective base stations 10 form radio zones Z1, Z2, … , in which mobile stations (MS) 20 can communicate with nearest base stations (BS) using predetermined or assigned radio channels. In Fig. 1, the base

15   stations 10 in the service area SA are connected to a visit mobile control center (VMCC) 30 and the base stations 10 in the service area SB are connected to a VMCC 40. The VMCCs 30 and 40 are further connected to a gateway mobile control center (GMCC) 50, which is connected to an existing fixed network such as

20   a public switched telephone network.

In a mobile station 20 such as a mobile telephone or mobile

information terminal (e.g. PDA: Personal Digital Assistant),
a first program-controlled processor (main CPU) controls the
entire operation thereof and a second program-controlled
processor (sub CPU) controls an external communication

5   operation such as radio communication under the control of
the main CPU. In such a mobile station, which may be
battery-powered, it is preferable to reduce its power
consumption as much as possible. Accordingly, there have been
proposed several techniques intended to reduce in power

10 consumption.

Japanese Patent Application Unexamined Publication No.
7-183976 discloses a facsimile machine equipped with a main
CPU and a sub CPU. In this facsimile machine, the sub CPU takes
charge of power supply control. When facsimile operations

15 including line connection, document reading and printing have
been completed, the main CPU instructs the sub CPU to turn off
a main power supply.

Japanese Patent Application Unexamined Publication No.
2000-347985 discloses a portable radio terminal which is

20 equipped with a main CPU for control the entire operation of
the terminal and a sub CPU for monitoring a SLEEP control task.

However, as known well, a battery-powered mobile station
transmits and receives control signals at regular intervals
or as necessary to and from a corresponding VMCC through a nearest

25 base station to perform its location registration, handover
operation, and the likes. The sub CPU may take charge of

controlling operations related to the external communication control such as location registration. In such a circuit structure, it is necessary for the sub CPU to control radio transmission and reception of control signals for location

5   registration and the likes at all times or regular intervals. This increases power consumption, resulting in reduced lifetime of a battery. It is the same with a mobile station connected to an external device such as a personal computer by a cable.

SUMMARY OF THE INVENTION

10   An object of the present invention is to provide a power supply control device and method, which allow reduced power consumption in a portable communication device equipped with a plurality of controllers.

According to the present invention, a power supply

15   control method in a portable communication device provided with a plurality of controllers including a main controller and a sub controller for controlling external communication, includes the steps of: a) checking whether the sub controller is performing the external communication; and b) when the

20   external communication has not been performed for a predetermined time-out period, powering off the sub controller.

The external communication may be radio communication with a mobile communications system for location registration

of the portable communication device. The external

communication may be wired communication with an external

information processing device through an external connector.

The step a) preferably includes the steps of: a.1) sending

5   an operation check request to the sub controller when an

operation check timer is reset for the predetermined time-out

period; and a.2) determining whether an operation check response

to the operation check request is received from the sub

controller, and the step b) preferably includes the steps of:

10   b.1) when the operation check response is not received from

the sub controller within the predetermined time-out period,

powering off the sub controller; and b.2) when the operation

check response is received from the sub controller within the

predetermined time-out period, keeping the sub controller

15   powered on.

The power supply control method may further include the

steps of: implementing at least an external interface task and

timer handler in the main controller; and implementing at least

an external communication monitoring task in the sub controller,

20   wherein the external interface task sends the operation check

request when the timer handler starts the operation check timer

and, when the operation check response is not received from

the sub controller within the predetermined time-out period,

powers off the sub controller, wherein the external

25   communication monitoring task sends the operation check

response back to the external interface task when the external

communication is being performed.

According to another aspect of the present invention, a portable communication device includes: a radio communication section for communicating with a base station of a mobile

5   communications system; a main CPU for controlling an entire operation of the portable communication device; a sub CPU for controlling external communication; a dual port memory connected to the main CPU at one port and connected to the sub CPU at the other port, for transferring messages between the main

10   CPU and the sub CPU, wherein the main CPU implements: operation check means for checking whether the sub controller is performing the external communication; and power control means controlling power supply of the sub controller such that the sub controller is powered off when the external communication has not been

15   performed for a predetermined time-out period, wherein the sub controller implements: response means for sending the operation check response back to the main controller when the external communication is being performed.

As described above, according to the present invention,

20   when the time required from transmission of the operation check request to reception of its response exceeds the predetermined time-out period or the response fails to be received within the predetermined time-out period, it is determined that no external communication is performed by the sub controller and

25   therefore the sub controller is powered off. Accordingly, power consumption can be reduced, resulting in elongated lifetime

of the battery.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing an example of a network configuration in which a portable telephone according to the

5   present invention may be used;

Fig. 2 is a block diagram showing a mobile telephone device according to an embodiment of the present invention;

Fig. 3 is a block diagram showing functional blocks of a main CPU and a sub CPU in the mobile telephone device according

10   to the embodiment of the present invention;

Fig. 4 is a sequence diagram showing message transfer between tasks implemented in the main CPU and the sub CPU in the mobile telephone device according to the embodiment of the present invention;

15   Fig. 5 is a sequence diagram showing a first example of normal message transfer between tasks implemented in the main CPU and the sub CPU;

Fig. 6 is a sequence diagram showing a second example

of normal message transfer between tasks implemented in the main

CPU and the sub CPU;

Fig. 7 is a sequence diagram showing a third example

of normal message transfer between tasks implemented in the main

5   CPU and the sub CPU;

Fig. 8 is a sequence diagram showing a first example of

failed message transfer between tasks implemented in the main

CPU and the sub CPU to start a sub CPU reset operation;

Fig. 9 is a sequence diagram showing a second example

10   of failed message transfer between tasks implemented in the main

CPU and the sub CPU to start the sub CPU reset operation;

Fig. 10 is a sequence diagram showing a third example

of failed message transfer between tasks implemented in the main

CPU and the sub CPU to start the sub CPU reset operation; and

15   Fig. 11 is a sequence diagram showing a fourth example

of failed message transfer between tasks implemented in the main

CPU and the sub CPU to start the sub CPU reset operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be described hereinafter, taking a mobile telephone as an example.

Referring to Fig. 2, a mobile telephone 20 according to an embodiment of the present invention is equipped with a first

5   controller (here, main CPU) 201 and a second controller (here, sub CPU) 202, which are connected by a DPRAM (Dual Port RAM) 203 so that the main CPU 201 performs control operations including an operation check of the sub CPU 202. The operation check, which will be described later, is to monitor an external

10   communication operation of the sub CPU 202 so as to determine whether the halt time period during which the sub CPU 202 does not perform any external communication control exceeds a predetermined time-out period. The DPRAM 203 has two ports each connected to the main CPU 201 and the sub CPU 202, allowing

15   the main CPU 201 and the sub CPU 202 to obtain access to the DPRAM 203 concurrently while one reading data and the other writing data. Accordingly, the DPRAM 203 is used to transfer data at high speed between the main CPU 201 and the sub CPU 202. The DPRAM 203 has a control memory area which stores an

20   operation check reset flag indicating that the sub CPU 202 is reset by the operation check processing.

The main CPU 201 is a program-controlled processor, on which control programs including an operation check program run to implement necessary tasks, which will be described later.

25   The control programs are stored in a ROM 204. The main CPU 201 is connected to or incorporates a timer and a clock generator,

which are not shown. The main CPU 201 may also be a
program-controlled processor.

The main CPU 201 is connected to a speech CODEC 205 connected
to a telephone receiver (speaker) and a telephone transmitter
5   (microphone), a display 206 such as LCD (liquid-crystal display),
and an input device 207 such as a keypad including a ten-key.
The main CPU 201 controls a power supply circuit 208 to
selectively supply power to the sub CPU 202, a radio
communication system 209, and other components. Under the
10   control of the main CPU 201, the radio communication system
209 and the speech CODEC 205 are used to perform voice
communication.

The sub CPU 202 controls the radio communication system
209 to perform radio communication for mobile telephone and
15   further controls an external communication circuit 210, which
is connected to an external connector 211. The external
connector 211 may be connected to an external device 212 such
as a personal computer. In other words, the sub CPU 202 performs
the external communication control by controlling the radio
20   communication system 209 or the external communication circuit
210. The external communication operation of the sub CPU 202
includes transmitting and receiving control signals to and from
an external device 212 or a nearest base station (BS) for the
location registration of the mobile telephone 20. As will be
25   described later, the sub CPU 202 monitors the radio communication
system 209 to determine whether control signals for location

registration, handover or the like are transmitted and received

to and from the VMCC through a nearest base station (BS).

The main CPU 201 monitors the external communication

operation of the sub CPU 202 to determine whether the halt time

5   period during which the sub CPU 202 does not perform any external

communication control exceeds a predetermined time-out period.

When the halt time exceeds the predetermined time-out period,

the main CPU 201 instructs the power supply circuit 208 to stop

supplying power to the sub CPU 202. Hereafter, the operation

10   check will be described in detail.

Operation Check

Referring to Fig. 3, the main CPU 201 implements an external

interface (EIF) task 2a, a sub-CPU controller 2b, a timer handler

2c, a transmission management task 2d, and a DPRAM handler 2e.

15   The EIF task 2a issues a primitive, or an operation check

request message, to the sub CPU 202 at predetermined time

intervals and waits for a response.

As described later, when no response has been received

within a predetermined time-out period, the EIF task 2a

20   determines that the sub CPU 202 has never performed any external

communication control for the predetermined time-out period

and therefore instructs the sub CPU controller 2b to stop

supplying the sub CPU 202 with power. The sub CPU controller

2b controls the power supply circuit 208 to selectively supply

25   power to the sub CPU 202 and other components and further controls

the clock generator to supply the timing clock to the sub CPU

202. When the EIF 2a is notified by the sub CPU controller

2b that the sub CPU 202 is powered off, the EIF 2a instructs

the timer handler 2c to stop the timer for operation check.

When the EIF 2a is notified by the sub CPU controller 2b that

5   the sub CPU controller 2b starts supplying the sub CPU 202 with

power, the EIF task 2a instructs the timer handler 2c to start

the timer for operation check.

The transmission management task 2d manages transmission

and reception of messages to and from the sub CPU 202. The

10   DPRAM handler 2e monitors transmission and reception of messages

to and from the sub CPU 202.

The sub CPU 202 implements a DPRAM handler 2f, an IDLE

task 2g, and a transmission management task 2h. The DPRAM

handler 2f monitors transmission and reception of messages to

15   and from the main CPU 201. The IDLE task 2g is an external

communication monitoring task that monitors the presence and

absence of external communication, for example, radio

transmission and reception of control signals to and from the

VMCC through a nearest base station (BS). When having received

20   the operation check request primitive from the EIF task 2a of

the main CPU 201, the IDLE task 2g sends the monitored result

as a response primitive to the operation check request primitive

back to the EIF task 2a of the main CPU 201. It should be noted

that the lowest task priority is given to the IDLE task 2g so

25   as to avoid the response action of the IDLE task 2g even though

some task is not allowed to operate.

Referring to Fig. 4, in the main CPU 201, the sub CPU
controller 2b instructs the power supply circuit 208 to supply
power to the sub CPU 201 and the clock generator to supply timing
clock to the sub CPU 202 (step A1). When the sub CPU 202 is

5   in power-on state, the sub CPU controller 2b notifies the EIF
task 2a that the sub CPU 202 is powered on and thereby the EIF
task 2a instructs the timer handler to start the timer for
operation check (step A2). Thereafter, messages are
transferred through the DPRAM 203 between the EIF task 2a and

10   the transmission management task 2h and between the
transmission management tasks 2d and 2h. Such message transfer
is monitored by the DPRAM handlers 2e and 2f.

In the case where the EIF task 2a calls on the DPRAM handler
2e to determine whether the operation check is needed before

15   a predetermined time has elapsed from the completion of
latest message transfer (step A3), its return value is indicative
of "operation check is not needed". When the EIF task 2a checks
the need of operation check after the predetermined time has
elapsed from the completion of latest message transfer (step

20   A4), its return value is indicative of "operation check
is needed".

When the operation check is needed, the EIF 2a resets
an operation check completion flag to "no response", instructs
the timer handler 2c to set the timer for a predetermined time-out

25   period, and then performs the operation check request to send
an operation check request message to the IDLE task 2g (step

A5).

When having received the operation check request message
from the EIF task 2a, the IDLE task 2g checks whether the external
communication control such as the location registration is
5   performed (step A6). When the external communication control
is being performed, the IDLE task 2g sends an operation check
response message back to the EIF task 2a. The EIF task 2a
determines whether the operation check response message is
received within the predetermined time-out period. If it is
10   received within the predetermined time-out period, then the
EIF task 2a sets the operation check response completion flag
to "response received". If the operation check response message
is not received within the predetermined time-out period, then
the operation check response completion flag remains set to
15   "no response" and thereby the EIF task 2a starts the operation
check time-out processing (step A7).

In the operation check time-out processing (step A7),
the EIF task 2a instructs the sub CPU controller 2b to stop
supplying the sub CPU 202 with power and timing clock (step
20   A8), sends the transmission management task 2d a message
indicating that the sub CPU controller 2b resets the sub CPU
202, and calls on initialization of the DPRAM handler 2e. In
addition, the EIF task 2a instructs the DPRAM handler 2e to
set the operation check reset flag to "reset by operation check".
25   When the EIF task 2a is notified of the cub CPU 202 being powered
off, the EIF task 2a instructs the timer handler 2c to stop

the timer for operation check (step A9). When the sub CPU 202

is powered on, the initialization is performed by looking at

the operation check reset flag in the DPRAM 203 indicating that

the sub CPU 202 has been reset by the operation check.

5   The operation check request and response processing (steps

A 5 and A6) will be described in details.

Referring to Fig. 5, the EIF 2a sends an operation check

request primitive SCPU_OPERATION_CHECK.REQ to the IDLE task

2g through the DPRAM handlers 2e and 2f. When the sub CPU 202

10   is normally performing the external communication control such

as the location registration, the IDLE task 2g sends an operation

check response primitive SCPU_OPERATION_CHECK.RSP back to the

EIF 2a through the DPRAM handlers 2f and 2e in response to the

operation check request primitive SCPU_OPERATION_CHECK.REQ.

15   The time required from transmission of the operation check

request primitive SCPU_OPERATION_CHECK.REQ to reception of the

operation check response primitive SCPU_OPERATION_CHECK.RSP

is normally shorter than the predetermined time-out period as

shown in Fig. 5.

20   As shown in Fig. 6, when the EIF 2a fails to send the

operation check request primitive SCPU_OPERATION_CHECK.REQ to

the DPRAM handler 2e, the EIF 2a tries to send the operation

check request primitive SCPU_OPERATION_CHECK.REQ again.

Accordingly, when the time required from the first failed

25   transmission of the operation check request primitive

SCPU_OPERATION_CHECK.REQ to the successful reception of the

operation check response primitive SCPU_OPERATION_CHECK.RSP
is shorter than the predetermined time-out period as shown in
Fig. 6, the operation check is successfully completed and it
is determined that the sub CPU 202 is normally operating.

5   As shown in Fig. 7, the EIF 2a successfully sends the
operation check request primitive SCPU_OPERATION_CHECK.REQ to
the IDLE task 2g but the IDLE task 2g fails to send an operation
check response primitive SCPU_OPERATION_CHECK.RSP back to the
DPRAM handler 2f in response to the operation check request
10   primitive SCPU_OPERATION_CHECK.REQ. In this case, the IDLE
task 2g tries to send an operation check response primitive
SCPU_OPERATION_CHECK.RSP again. Accordingly, when the time
required from the transmission of the operation check request
primitive SCPU_OPERATION_CHECK.REQ to the successful reception
15   of the operation check response primitive
SCPU_OPERATION_CHECK.RSP is shorter than the predetermined
time-out period as shown in Fig. 7, the operation check is
successfully completed and it is determined that the sub CPU
202 is normally operating.

20   In the case where transmission and reception of control
signals to and from the VMCC are not performed, the IDLE task
2g does not respond to the operation check request primitive
SCPU_OPERATION_CHECK.REQ and therefore time-out occurs at the
EIF task 2a. There are also other cases that the EIF task 2a
25   fails to transmit the operation check request or receive the
operation check response. Several variations of such failed

transmission and reception of the operation check response will

be described hereafter.

As shown in Fig. 8, when the EIF 2a fails to send the

operation check request primitive SCPU_OPERATION_CHECK.REQ to

5   the DPRAM handler 2e, the EIF 2a repeatedly tries to send the

operation check request primitive SCPU_OPERATION_CHECK.REQ.

When the predetermined time-out period has elapsed from the

first transmission of the operation check request primitive

SCPU_OPERATION_CHECK.REQ (here, failed transmission is

10   repeated five times), the EIF task 2a notifies the

transmission management task 2d that the sub CPU 202 should

be reset.   Further, the EIF task 2a writes its reset cause into

the DPRAM 203 by setting the operation check reset flag of the

DPRAM 203 so as to indicate that the sub CPU 202 is reset by

15   the operation check (step B1), instructs the sub CPU controller

2b to stop supplying power to the sub CPU 202 (step B2), and

initializes the DPRAM 203 (step B3).

As shown in Fig. 9, the EIF 2a sends the operation check

request primitive SCPU_OPERATION_CHECK.REQ to the sub CPU 202

20   but the DP handler 2f fails to send the operation check request

primitive SCPU_OPERATION_CHECK.REQ to the IDLE task 2g.   In

such a situation, when the predetermined time-out period has

elapsed from the transmission of the operation check request

primitive SCPU_OPERATION_CHECK.REQ, the EIF task 2a notifies

25   the transmission management task 2d that the sub CPU 202 should

be reset.   Further, the EIF task 2a writes its reset cause into

the DPRAM 203 by setting the operation check reset flag of the

DPRAM 203 so as to indicate that the sub CPU 202 is reset by

the operation check (step C1), instructs the sub CPU controller

2b to stop supplying power to the sub CPU 202 (step C2), and

5   initializes the DPRAM 203 (step C3).

As shown in Fig. 10, the EIF 2a sends the operation check

request primitive SCPU_OPERATION_CHECK.REQ to the IDLE task

2g but the IDLE task 2g fails to receive the operation check

request primitive SCPU_OPERATION_CHECK.REQ. Such failed

10   reception of the IDLE task 2g may be caused by erroneously

switching the operation check request primitive

SCPU_OPERATION_CHECK.REQ. In such a situation, when the

predetermined time-out period has elapsed from the transmission

of the operation check request primitive

15   SCPU_OPERATION_CHECK.REQ, the EIF task 2a notifies the

transmission management task 2d that the sub CPU 202 should

be reset. Further, the EIF task 2a writes its reset cause into

the DPRAM 203 by setting the operation check reset flag of the

DPRAM 203 so as to indicate that the sub CPU 202 is reset by

20   the operation check (step D1), instructs the sub CPU controller

2b to stop supplying power to the sub CPU 202 (step D2), and

initializes the DPRAM 203 (step D3).

As shown in Fig. 11, the EIF 2a successfully sends the

operation check request primitive SCPU_OPERATION_CHECK.REQ to

25   the IDLE task 2g but the IDLE task 2g fails to send an operation

check response primitive SCPU_OPERATION_CHECK.RSP back to the

DPRAM handler 2f in response to the operation check request

primitive SCPU_OPERATION_CHECK.REQ. In this case, the IDLE

task 2g tries to send an operation check response primitive

SCPU_OPERATION_CHECK.RSP five times. Accordingly, when the

5   predetermined time-out period has elapsed from the transmission

of the operation check request primitive

SCPU_OPERATION_CHECK.REQ, the EIF task 2a notifies the

transmission management task 2d that the sub CPU 202 should

be reset. Further, the EIF task 2a writes its reset cause into

10   the DPRAM 203 by setting the operation check reset flag of the

DPRAM 203 so as to indicate that the sub CPU 202 is reset by

the operation check (step E1), instructs the sub CPU controller

2b to stop supplying power to the sub CPU 202 (step E2), and

initializes the DPRAM 203 (step E3).

15   As described above, according to the embodiment of the

present invention, when the time required from transmission

of the operation check request to reception of its response

exceeds the predetermined time-out period or the response fails

to be received within the predetermined time-out period, it

20   is determined that no external communication control is

performed by the sub CPU 202 and therefore the EIF task 2a

instructs the sub CPU controller 2b to stop supplying power

to the sub CPU 202, resulting in reduced power consumption and

elongated lifetime of the battery.

25   The present invention is not limited to the

above-described embodiment in which the mobile telephone 20

is connected to the base station by radio.   The present invention
can be applied to another embodiment in which the mobile
telephone 20 is connected to a personal computer 212 by the
external connector 211 because the sub CPU 202 controls the

5   transmission and reception of messages to and from the personal
computer 212.   Further, the present invention can be applied
to any type of battery-powered multi-controller mobile station
equipped with a main controller for controlling the entire
operation thereof and a sub controller for controlling the

10   external communication.